IS 10236-1 (1989): Procedure for basic climatic and durability tests for optical instruments, Part 1: General [PGD 22: Educational Instruments and Equipment]

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(Reaffirmed 1999)

Indian Standard

PROCEDURE FOR BASIC CLIMATIC AND DURABILITY TESTS FOR OPTICAL INSTRUMENTS

PART 1 GENERAL

UDC 681·7 : 620·193·21

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 5

FOREWORD

This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards on 7 June 1989, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

Fast development in the field of instruments has brought a significant change in their basic content and design. It has been felt over the years that an old Indian Standard on the same subject, namely IS 2352 : 1963 no longer caters to the present day needs of the instruments and is also not in line with the recent trends in climatic and durability testing procedures to be adopted for improving their quality and reliability. It has, therefore, become necessary to have uniform and more rational testing procedures, as far as possible. This series of standards (IS : 10236) on climatic and durability tests has been prepared with this objective.

It is proposed to withdraw the existing Indian Standard IS 2352 : 1963 as soon as the tests mentioned therein are covered in the new series IS 10236.

This standard [IS : 10236 (Part 1)] covers the general information, details of test equipment, test severities and detailed procedures for a number of basic climatic and durability tests as applicable to optical instruments which are in use for various applications. The various parts of this standard are listed in 2 of this standard.

The basic testing procedures included in this series of standards have been based upon available engineering experience and judgement and are designed to provide information on the following properties of optical instruments:

a) The ability to operate within specified limits of temperature, pressure, humidity, or certain combinations of these conditions, and

b) Mechanical robustness.

To cover the possible varieties of conditions in which different instruments are required to perform and/or to provide tests appropriate to different intensities of an environmental condition, the test procedures have a number of test severities. These test severities are obtained by varying the time, temperature, pressure or some other determining factors separately or in combination with each other.

While preparing specification for a particular optical instrument on the basis of this standard, only those tests and their severities would be specified in the relevant instrument specification which are necessary for that instrument, taking into account its use and actual service environments and the technical and economic aspects.

The deviation in testing procedure or adoption of any special procedure, where necessary, may be included in the relevant instrument specification. In the event of conflict between this standard and the relevant instrument specification, the latter in all cases shall prevail.

The requirements and limits in respect of performance of the instrument during and after exposure to the environmental conditions are not covered by this series of standards on climatic and durability testing procedures. Where it is necessary, the relevant instrument specification may provide these requirements and performance limits during and after environmental testing.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

PROCEDURE FOR BASIC CLIMATIC AND DURABILITY TESTS FOR OPTICAL INSTRUMENTS

PART 1 GENERAL

1 SCOPE

1.1 This standard (Part 1) covers general conditions applicable to all the climatic and mechanical robustness tests and lists all the tests with their severities useful in the environmental assessment of optical instruments.

1.2 The standard does not include testing procedures and also does not indicate the specific tests to be conducted on a particular instrument, the severity to be chosen or the performance to be expected. These may be covered by the different parts of this standard and by the relevant instrument specification prepared particularly for that instrument.

2 REFERENCES

IS No.	*Title*
IS 10236	Procedure for basic climatic and durability test for optical instruments:
(Part 2) : 1982	Dry heat test
(Part 3) : 1982	Cold test
(Part 4) : 1982	Damp heat test
(Part 5) : 1982	Damp heat (cyclic) test
(Part 6) : 1982	Salt mist test
(Part 7) : 1983	Mould growth test
(Part 8) : 1983	Thermal shock (rapid change of temperature) test
(Part 9) : 1983	Low air pressure (altitude) test
(Part 10) : 1985	Bump test
(Part 11) : 1985	Vibration test
(Part 12) : 1985	Shock test
(Part 13) : 1986	Dust test
(Part 14) : 1986	Driving rain test
(Part 15) : 1986	Drop test
(Part 16) : 1988	Solar radiation test
(Part 17) : 1988	Acceleration (steady state) test
(Part 18) : 1988	Sealing test

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Ambient Temperature

The temperature of the air within the chamber or room surrounding the instrument.

3.2 Climatic Tests

Tests designed to determine the performance of the instrument under conditions directly or indirectly related to climatic parameters temperature, pressure, humidity, rain, dust, fungus, solar, namely, radiation and atmospheric salinity.

3.3 Conditioning

The process of exposing the test instrument to an environmental condition in order to determine the effect of such a condition on it.

3.4 Environmental Testing

It is the science of testing any component or instrument under some or all the conditions and influences which affect its operation and life.

3.5 Mechanical Robustness Test

Tests designed to evaluate the performance of the instrument under conditions of acceleration and different types of mechanical shocks and vibrations during transportation, use and storage.

3.6 Initial Measurements

Measurements made as the first act in a series of operations to determine the characteristics of the item to be compared with its characteristics after the conclusion of the test.

3.7 Final Measurements

Measurements made at the conclusion of a series of operations so that a comparison with the initial measurements (*see* **3.6**) will show the effect the entire operation has had on the item under test.

3.8 Preconditioning

The treatment of an item with the object of removing or partly counteracting the effects of its previous history. Where called for, it is the first process in a test procedure.

3.9 Recovery

The climatic conditions under which the item is maintained for a specific period after exposure to conditioning in order that it may return to a stable state before the final measurements.

3.10 Relevant Instrument Specification

A document specially drawn up or provided for an instrument which lays down a set of requirements and performance capabilities of the instrument, indicating the procedure necessary to determine whether these requirements and performance capabilities are satisfied.

3.11 Type Approval Tests

Tests performed on an instrument in its final form to ascertain its compliance with the specified requirements.

3.12 Visual Examination

The examination of the instrument visually made during initial and final measurements, in which defects in construction, presence of foreign bodies, moisture, dust, etc, corrosion of metal parts, deterioration of materials and finishes, mechanical distortion, etc, are noted.

4 STANDARD ATMOSPHERIC CONDITIONS

4.1 Standard Reference Conditions

If the parameters to be measured depend on temperature and/or air pressure and if the law of dependence is known, the values shall be measured under the conditions specified at **4.3** and, if necessary, be corrected by calculation to the following reference values:

a) Temperature : 27°C, and

b) Air pressure : 101·3 kPa*

NOTE — No requirement for relative humidity is given because its correction by calculation is generally not possible.

4.2 Standard Referee Conditions

If the parameters to be measured depend on temperature, and/or air pressure and/or relative humidity and if the law of dependence is not known, the measurements shall be made under the following referee conditions:

a) Temperature : 27 ± 2°C,

b) Relative humidity : 65 to 75 percent, and

c) Air pressure : 86 to 106 kPa*

4.3 Standard Testing Conditions

Initial and final measurements shall be made under any condition of temperature, relative humidity and air pressure within the following limits generally prevailing in laboratories:

a) Temperature : 17 to 37°C,

b) Relative humidity : 45 to 75 percent, and

c) Air pressure : 86 to 106 kPa*

4.3.1 When it is not practicable or necessary to make measurements under the conditions stated in **4.3**, a note to this effect, if required, stating the actual conditions shall be added to the test report.

4.4 Standard Recovery Conditions

The standard atmospheric conditions for recovery shall be as specified in **4.3** unless closer control of temperature and humidity is required. In such a case, the standard referee conditions given in **4.2** shall be used for recovery.

5 OUTLINE OF TESTS AND DEGREES OF SEVERITY

5.1 The tests with their different test severities are listed in Table 1, for general guidance.

5.1.1 The tests shown in Table 1 may in themselves consist of a series of operations in order to determine the effect of such test, or a series of tests on an item. The series of operations are:

a) preconditioning, if required;

b) initial measurements;

c) conditioning;

d) recovery; and

e) final measurements.

6 REQUIREMENTS OF EQUIPMENT FOR TESTS

6.1 The requirements and other essential details of test equipment, such as, climatic chamber, and vibration equipment shall be as specified in different parts of this standard.

7 SEQUENCE OF TESTS

7.1 A general sequence of tests for optical instruments is given in Annex A. The dynamic tests have been taken before climatic tests in this sequence on the consideration that climate-sensitive defects often show up more clearly after the application of shock and vibration forces.

7.2 Though the above sequence is considered to be most practical and logical, it cannot be ideal for all types of instruments and their field of usage. The relevant instrument specification should, therefore, specify a sequence of tests where it is considered necessary.

*1 kPa = 10 m bar = 7·500 6 mm of Hg.

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Table 1 Outline of Tests and Test Severities

(*Clauses* 5.1 *and* 5.1.1)

Sl No.	Test	Test Severities	Part of This Standard to be Referred to
(1)	(2)	(3)	(4)
1	Dry heat	Exposure for 16 hours or 96 hours at one of the temperatures given below: 100, 85, 70, 55, 40 ± 3°C	2
2	Cold	Exposure for 4 hours or 16 hours at one of the temperatures given below: −65, −55, −40, −30, −20, −10 ± 3°C	3
3	Damp heat	Exposure to a humid atmosphere for required number of cycles: each cycle consisting of 16 hours at one of the temperatures given below and the remaining time utilized for heating, cooling and keeping the test item at laboratory temperature inside a chamber to complete 24 hours. During this 24 hours period, high humidity shall also be maintained inside the chamber. I 40 ± 2°C — RH : 95 to 100 percent, No of cycles: 2 or 6 II 55 ± 2°C — RH : 95 to 100 percent, No of cycles: 1, 2 or 6	4
4	Damp heat (cyclic)	Exposure to humid atmosphere for required number of cycles; each cycle consisting of 12 hours at 40 ± 2°C and 6 hours at 20 ± 2°C and 6 hours for slow heating and cooling process to complete 24 hours I 7 cycles, II 14 cycles, III 28 cycles, IV 56 cycles, V 84 cycles — RH, not less than 95 percent	5
5	Salt mist	Exposure to salt mist for 2 hours followed by storage at 35 ± 2°C with RH 90 to 95 percent *Severity* / *Number of Cycles* / *Duration of Each Cycle* I / 3 / 24 hours II / 4 / 7 days	6
6	Mould growth	Exposure to selected moulds for 28 days at temperature of 29 ± 1°C and at RH more than 95 percent	7

Table 1 (*Continued*)

Sl No.	Test	Test Severities	Part of This Standard to be Referred to
(1)	(2)	(3)	(4)
7	Thermal shock: (Rapid change of temperature)	Exposure for 3 hours at high temperature and then for 3 hours at low temperature after quick transference (1 cycle) *Severity* — *High Temp* — *Low Temp* — *Cycles* I — 70 ± 3°C — −40 ± 3°C II — 70 ± 3°C — −30 ± 3°C III — 55 ± 3°C — −20 ± 3°C IV — 55 ± 3°C — −10 ± 3°C Cycles: 3	8
8	Low air pressure (Altitude)	Exposure for 4 hours or 8 hours to an atmosphere of (i) low pressure, or (ii) low pressure and low temperature selected from the following: a) Low pressure (Accuracy ± 5 %) *Altitude* — *Pressure* (mm of Hg) — *Pressure* (kPa) 20 000 m — 15·0 — 2·0 20 000 — 33·0 — 4·4 16 000 — 64·0 — 8·5 13 200 — 112·5 — 15·0 8 500 — 225·0 — 30·0 4 300 — 400·0 — 53·3 3 500 — 450·0 — 60·0 b) Low temperature −55, −40, −20, −10 ± 3°C	9
9	Bump	a) Total bumps : 1 000 ± 10 b) Total bumps : 4 000 ± 10 At a rate of 1 to 3 bumps per second The basic pulse shape for each bump shall be half sine with peak acceleration 40 ± 4 *g* and duration 6 ± 1 ms	10
10	Vibration	The vibration severity shall be given by a combination of three parameters: (a) frequency range, (b) vibration amplitude, and (c) endurance duration which can be chosen in each case from the values given in Annex B	11
11	Shock	One shock severity from the table given in Annex C shall be chosen. For the selected pulse shape, the shock severity shall be defined by a combination of peak acceleration and the duration of ideal pulse	12
12	Dust	Exposure to an atmosphere consisting of dust particles of size 150 µm or less under one of the following severities: I 50 ± 3°C for 2 hours II 40 ± 3°C for 1 hour III 40 ± 3°C for 1/2 hour RH not exceeding 50 percent	13

Table 1 (*Continued*)

Sl No.	Test	Test Severities	Part of This Standard to be Referred to
(1)	(2)	(3)	(4)
13	Driving rain	I Spraying with clean water for one hour using eight shower heads* II Spraying with clean water for one hour using four shower heads* directed downward at an angle of 45° *Each shower head while spraying shall be at a static pressure of 200 kPa ± 15 percent and its spraying rate shall be 450 litres ± 10 percent of water per hour	14
14	Drop	a) Drop on a 15 cm thick sand bed: *Severity* — *Height of Fall* (cm) A1 150, B1 120, C1 90, D1 60, E1 30 — With or without case b) Drop on a 6 mm thick steel test plate: *Severity* — *Height of Fall* (cm) A2 10·0, B2 5·0, C2 2·5 — Instrument not in its case A3 100, B3 50, C3 25 — Instrument in its case	15
15	Solar radiation	I Irradiation of 8 h, out of which 4 h at 55 ± 2°C, according to Fig. 1A II Irradiation of 8 h, out of which 4 h at 40 ± 2°C, according to Fig. 1A (This is to be specified if the instrument is to be used only in cold region) III Irradiation of 20 h, out of which 18 h at 55 ± 2°C, according to Fig. 1B IV Irradiation of 20 h, out of which 18 h at 40 ± 2°C, according to Fig. 1(B) (This is to be specified if the instrument is to be used only in cold region) — Number of cycles according to the relevant instrument specification (Refer to **7.1.4** of Part 16 of this standard)	16
16	Acceleration (steady state)	The *g*-level to be applied to the instrument is dependent on two factors: (a) the direction of forward acceleration level '*A*' of the vehicle, and (b) the orientation of the instrument within the vehicle, where '*A*' is the highest possible known or unknown forward acceleration of a vehicle in which the instrument is to be mounted. '*A*' shall never be less than the *g*-level The severity levels shall be selected from those given in Annex D, Tables 3 and 4 depending upon the procedure of the test. In general, the test duration shall be one minute and test shall be carried out along both the senses of three mutually perpendicular axes in turn	17

Table 1 (*Concluded*)

Sl No.	Test	Test Severities			Part of This Standard to be Referred to
(1)	(2)	(3)			(4)
17	Sealing	*Severity*	*Leakage rate at 0·175 kg/cm² Excess Internal Pressure*	*Type of Instrument*	18
		I	0 cc/minute	Hermetically sealed and fully tropicalized	
		II	Up to 3 cc/minute	Semi-tropicalized	
		III	Up to 10 cc/minute	Partially sealed for civilian use	
		NOTE — In case of above severities, the leakage rate, in cc/minute at 0·175 kg/cm² excess internal pressure shall, as far as possible, not be more than 1 percent of the internal empty volume in cc of the instrument.			

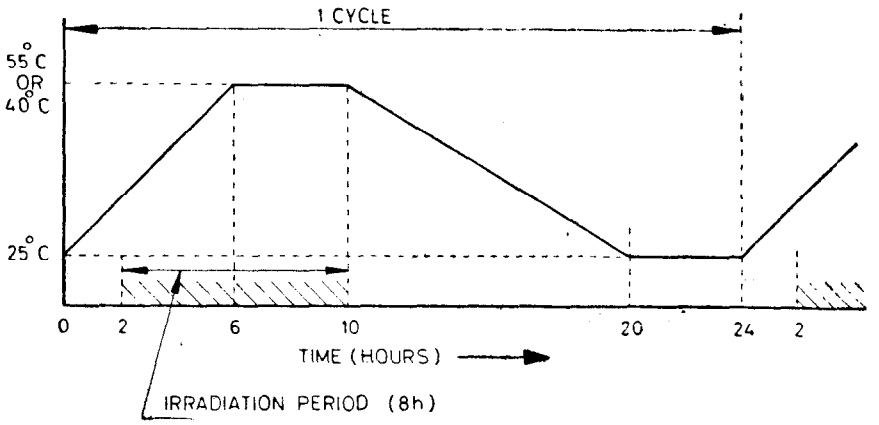

FIG. 1A

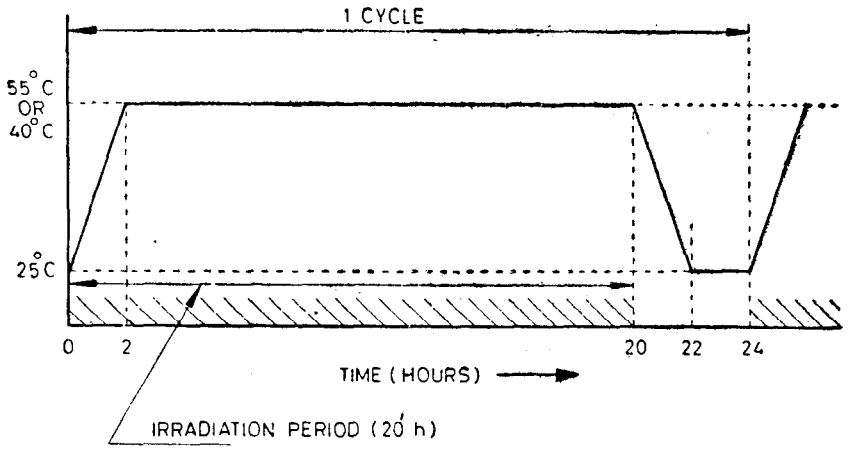

FIG. 1B

FIG. 1 TEMPERATURE IRRADIATION DURATION CYCLE GRAPH

ANNEX A

(*Clause* 7.1)

GENERAL SEQUENCE OF TESTS FOR OPTICAL INSTRUMENTS

The sequence of tests to be performed for optical instruments is in the following order:

a) Vibration test,
b) Acceleration (steady state) test (*see* Note 1),
c) Bump test,
d) Shock test,
e) Drop test,
f) Sealing test,
g) Cold test,
h) Dry heat test
j) Damp heat test,
k) Thermal shock (rapid change of temperature) test (*see* Note 2),
m) Low air pressure (altitude) test,
n) Damp heat (Cyclic) test (*see* Note 3),
p) Sealing test,
q) Driving rain test,
r) Mould growth test (*see* Note 3),
s) Salt mist test (*see* Note 3),
t) Dust test, and
u) Solar radiation test (*see* Note 4).

NOTES

1 The test is applicable to instruments and devices that are installed in aircrafts, helicopters and manned aero-space vehicles.

2 The test is applicable to instrument which may experience extreme rapid temperature changes in its anticipated area or mode of deployment.

3 Separate instrument may be used for this test.

4 The test is applicable if the instrument is likely to be exposed for a considerable period to solar radiation in the open in hot climates, and the effects are of concern.

ANNEX B

[*Table* 1, *Item* (10)]

COMBINATION OF PARAMETERS FOR THE CHOICE OF VIBRATION SEVERITY

The combination of parameters for the choice of vibration severity are as follows:

a) *Frequency Range*

One range from the following shall be specified. In some cases, the range may be divided into two or more intervals, each with different amplitude. In such cases, different range intervals with amplitude for each interval shall be specified.

1) 1 to 10 Hz,
2) 5 to 35 Hz,
3) 5 to 55 Hz,
4) 5 to 150 Hz,
5) 5 to 350 Hz,
6) 10 to 500 Hz,
7) 10 to 1 000 Hz, and
8) 10 to 2 000 Hz.

b) *Vibration Amplitude (Displacement/Acceleration)* —Below and above the crossover frequency are given in Tables 2 and 3, respectively.

c) *Endurance Duration*—The endurance duration shall cover testing in three mutually perpendicular axes and shall be chosen from the following:

15, 30, 60, 90 minutes, 3, 6, 9, 12, 30, 50, 150 hours.

Table 2 Displacement Amplitude Below the Cross-Over Frequency

mm
0·075
0·125
0·15
0·25
0·35
0·50
0·75
1·00
1·25
1·50
2·00
2·50
3·50
6·00
10·00
100·00*

*These values are applicable to the 1 to 10 Hz range only.

Table 3 Acceleration Amplitude Above the Cross-Over Frequency

g	m/s²
0·5	4·9
1·0	9·8
2·0	19·6
3·0	29·5
4·0	39·2
5·0	49·0
10·0	98·0
15·0	147·0
20·0	196·0
30·0	294·0
50·0	490·0

ANNEX C

[*Table* 1, *Item* (11)]

TEST SEVERITY FOR SHOCK TEST

Severity	Half-Sine		Severity	Final-Peak Saw-Tooth	
	Peak Acceleration (*A*) *g* (Equivalent m/s²)	Corresponding Duration of the Pulse (*D*) ms		Peak Acceleration (*A*) *g* (Equivalent m/s²)	Corresponding Duration of the Pulse (*D*) ms
A1	15 (147)	11	A2	20 (196)	11
B1	30 (294)	11	B2	30 (294)	11
C1	30 (294)	18	C2	40 (392)	11
D1	40 (392)	18	D2	40 (392)	18
E1	50 (490)	11	E2	50 (490)	11
F1	75 (736)	6	F2	75 (736)	11
G1	75 (736)	11	G2	100 (981)	6
H1	100 (981)	6			
I1	500 (4 900)	1			
J1	1 000 (9 810)	0·5			
K1	1 500 (14 700)	0·5			
L1	3 000 (29 400)	0·2			

ANNEX D

[*Table* 1, *Item* (16)]

SEVERITY LEVELS FOR ACCELERATION (STEADY STATE) TEST

Table 4 *g* Levels for Structural Test (Procedure 1)

Vehicle Category	Forward Acceleration (see Note) 'A'	Test Level				
		Direction of Vehicle Acceleration				
		Fore	Aft	Up	Down	Lateral (Two Directions)
Aircrafts	2·0	1·5 × A	4·5 × A	6·75 × A	2·25 × A	3·0 × A
Helicopters	*See* Note	4·0	4·0	10·5	4·5	6·0
Manned aerospace vehicles	6·0 to 12·0	1·5 × A	0·5 × A	2·25 × A	0·75 × A	1·0 × A

NOTE — Levels given in column of forward acceleration above shall be used when forward acceleration is unknown. When the forward acceleration of the vehicle is known, that level shall be used for '*A*'. For helicopters, forward acceleration is unrelated to the acceleration in other directions.

Table 5 *g* Levels for Operational Test (Procedure 2)

Vehicle Category	Forward Acceleration (see Note) 'A'	Test Level				
		Direction of Vehicle Acceleration				
		Fore	Aft	Up	Down	Lateral (Two Directions)
Aircrafts	2·0	1·0 × A	3·0 × A	4·5 × A	1·5 × A	2·0 × A
Helicopters	*See* Note	2·0	2·0	7·0	3·0	4·0
Manned aerospace vehicles	6·0 to 12·0	1·0 × A	0·33 × A	1·5 × A	0·5 × A	0·66 × A

NOTE — Levels given in column of forward acceleration above shall be used when forward acceleration is unknown. When the forward acceleration of the vehicle is known, that level shall be used for '*A*'. For helicopters, forward acceleration is unrelated to the acceleration in other directions.

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